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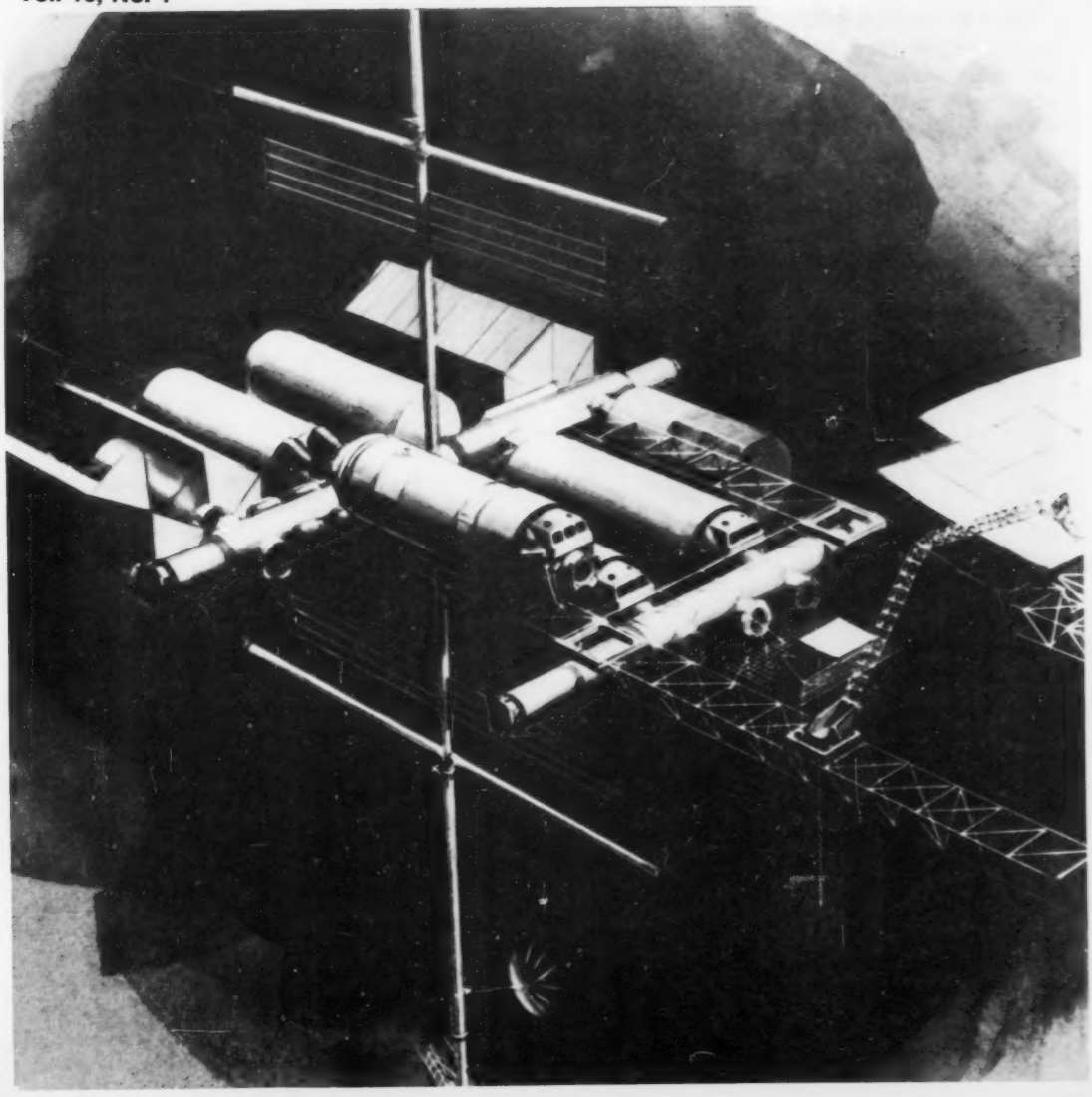

About the Cover

Designer's concept of an advanced Space Operations Center showing some of the modules that would comprise the system. Under contract with NASA's Johnson Space Center, Houston, Boeing Aerospace Company is studying the feasibility of such a station. Two habitat modules with viewing windows in the middle of the artwork would serve as living quarters and command control quarters for a normal crew of eight. The module above the habitat modules is a manned Orbital Transfer Vehicle which could take payloads from low Earth orbit to a higher orbit in space.

Below is an artist's concept of an outerspace satellite service system that would repair, refurbish or prepare orbiting spacecraft for return to earth. Lockhead Missiles & Space Co., Inc., is investigating the feasibility of such a system for NASA's Johnson Space Center, Houston. The study centers on what economic benefits will be gained from using the Space Shuttle to operate a satellite service system, what kinds of cargo containers must be developed to hold satellites destined for earthside refurbishment, and what kinds of maintenance services must be available for specific satellites.

Correction—On page 5 of the November 1981 issue of *NASA Activities* the painting shown at page bottom was incorrectly identified. It should have been cited as "Morning Thunder", an oil painting by artist Wilson Hurley, depicting the first launch of the Space Shuttle *Columbia* on April 12, 1981.

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Letter from Washington

For this issue of *NASA Activities* in 1982, I wanted to address all of you on what I believe is NASA's role, both now and in the future.

Basically, NASA's role will remain what it has been in the past—a continued balanced program in space exploration, manned space flight, aeronautics and applications. However, as to what level these activities will take place is a harder question. In real terms, in the last 10 years the NASA budget has decreased about 20 to 25 percent. The hope is that sometime in the next few years to get that downward trend turned up and instead of spending on the order of $6 or 6.5 billion, to spend the equivalent of about 5 years ago—about $7 or $7.5 billion, which gets us back to approximately one percent of the federal expenditure level.

Even considering OMB's budgetary targets, I believe this is a realistic expectation. A number of things have developed in the last two or three years that support this belief. One of these is an increased realization by the general public, as well as by specific constituencies, that the United States is not doing the necessary activity to maintain our technological lead in the world. I think the public perceives that the loss of competitiveness of American industry, and the decline in research and development expenditures in general, have resulted in foreign countries starting to move ahead of us. A further perception is that the Europeans and Japanese are somehow coming along faster than we are in accelerating their activities broadly in the research and development areas.

This perception translates into aiding NASA in its mission with the result that the NASA program, which happens to be the most visible research and development program in the federal government and in the country, has become more popular. Recent polls indicate that the majority of the public thinks what NASA's doing is proper and right, and that we should spend at least that amount of money on space research and technology development.

Moreover, a Harris Poll indicates that 40 percent of the public thinks we should be spending more—the highest percentage in the history of our agency—even in the halcyon days of Apollo, when NASA was very popular. So I believe that all of these things have convinced the public that perhaps we're not doing enough. And I believe this public realization represents a constituency.

I think that's a good sign because that usually transfers itself into politics. For example, a Presidential candidate in 1984 could give platform support for fiscal responsibility and control of the federal budget while also maintaining that research and development in the United States has been neglected and that the country should be spending more in this area, particularly as expressed in the space and aeronautics program. I think that would get a very positive response from the electorate.

In fact, this statement exists in the 1980 Republican platform. And I remind people in the Administration of this all the time.

The problem that this Administration is having is that the number one item on the agenda is cutting the federal budget. The feeling is that they can hardly cut food stamps and not cut, to some extent, the space program. It's as simple as that. That's the general rationale as to why we're getting cut along with everyone else.

The public perception that I would like to see corrected regards research and development abroad and the thought that the United States has lost its lead role in this competition. This is not entirely true and this is a very complex arena. In space foreign competition is very strong in communications and will increase in remote sensing, while the Europeans are spending only on the order of $1 to $1.5 billion on their space activities. However, they are focusing that expenditure in very specific areas, areas where they feel they can get substantial payoff: in the Ariane launcher program, the SPOT Earth resources spacecraft and in the communications satellite field, where they now compete worldwide.

Currently there are four countries out for bid on a communications satellite. Three of them are in Central and South America and the other one is Australia. In all four of these, the French and the Japanese are competing and they are competing very effectively with technology as good as ours and with prices as good as ours, including the usual extras such as better financing. The communications satellite field is the first place that they have moved into what has been a U.S. monopoly. In other areas, however, the United States clearly dominates the world—in space technology and aeronautics. We

also do well in cybernetics and in things like machine tools, but the industrial world is coming fast.

In other areas, however, we are losing ground as well, and it's because foreign nations are focusing their efforts in areas where they see a fairly sizeable commercial payoff. It is true that almost all of that is building upon foundations laid by NASA over the past couple of decades, which is of scant solace. You could make a sweeping generalization which, like all generalizations, is probably wrong—that the whole Japanese economy is based on American technology But they have taken that technology and moved it forward to make a very effective, highly competitive economy, one which has resulted in a vast increase in their standard of living and has resulted in an enormous competitive posture with the rest of the world.

As an open society, the United States publishes almost everything we do. Japan can use our technology; indeed, we have given it to them. In the past we went around the world passing off these very valuable gifts, like license-free use of all NASA technology.

This in turn raises a related question: When does NASA research and development become ready for commercial utilization? How and who makes the decision and at what stage does this transfer happen?

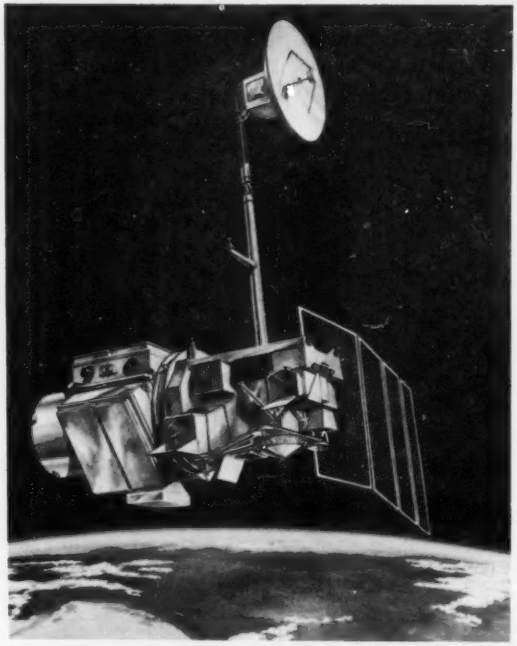
I've spent most of my life in business and timing of commercialization is the most difficult thing in the world to determine. The analog in the business world is the translation of technology into a new product and the marketing of that product. The problem is that "we" (meaning the country) don't know how to do that very well. The manifestation of that problem is some 80 or 90 percent of all new products fail in the commercial world. We have tried a lot of ways to improve that percentage: test market techniques, market studies, research as to requirements and needs and so forth. We must try to do the same thing here in NASA applications.

Landsat, as a current example, is something in which there was a lot of thought by NASA as to its potential commercial fallout. The conclusion was that there was a market, and indeed there is a market without any question. Is it a commercially viable market though? This is the second question you must ask yourselves. The problem is that a big part of the market are individuals who wouldn't otherwise pay the full cost of the data.

The largest Landsat user is the government. The other part of the market are commercial users. In their case they want, to some degree, confidentiality in the data they obtain. It's both a necessity and a hard requirement for most of them because, if they're going to use the data, for example in drilling a well, or in trying to exploit a natural resource, or for estimating crop yield, the large commercial users would like to be sure that that data is known only to them, since they must make very large investments.

To translate technology like Landsat into commercial reality, I believe we must rely on the entrepreneur, because this is the person who must decide whether a market can be developed around a specific system. Typically, we in the government are not very good entrepreneurs. NASA is very good at doing the basic research and understanding the system aspects. When it comes to trying to figure out whether there's a market or not, we don't do that very well.

And if you're going to attract entrepreneurs in the field then you've got to give them a fairly broad license to do with the system almost what they will. He's taking the risk; he's going out and raising the venture capital, and the government should encourage this process. The trouble with that is that it may turn out in a much different way than you expect, and you may not like the results. When you



Artist's concept of Landsat-D to be launched July 1982.

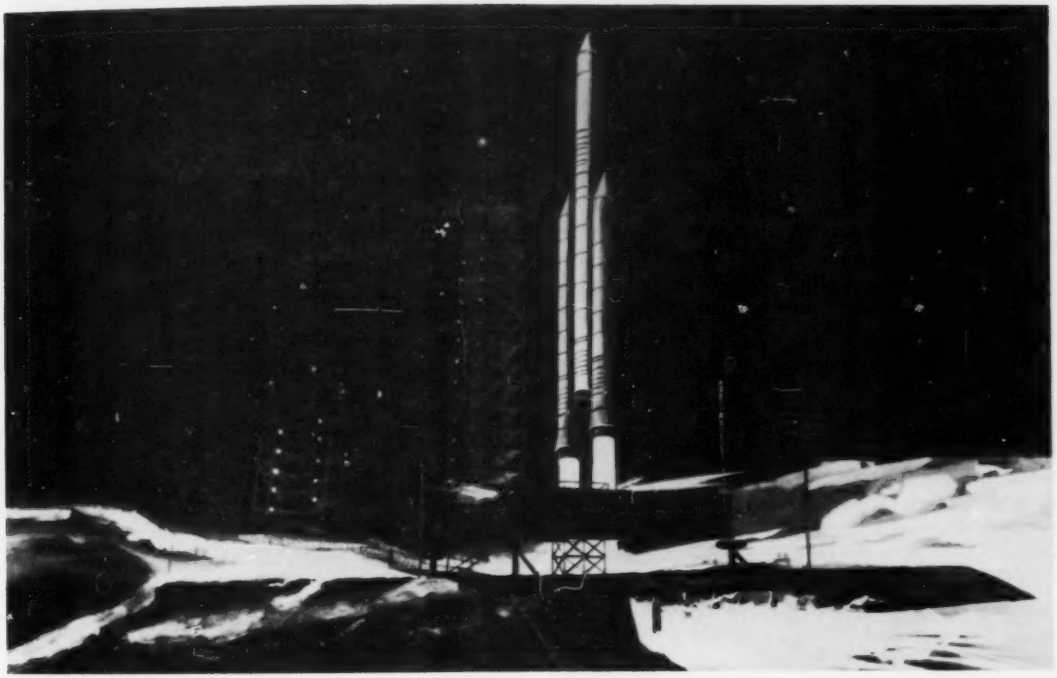
don't like the result, the only answer is to pass another law, hoping to enforce market sharing.

This, of course, would tend to make future entrepreneurs wary. That's why a lot of entrepreneurs are scared to death of the government anyway. In order to allay their fears we must encourage the private sector by easing regulation and control. For example, there are several bills before Congress right now on patent rights which I heartily support. If enacted, when a contractor develops a patent under government funding, royalty-free rights to develop this patent are granted. The only exception is that royalty-free rights also must be guaranteed to the government if the government wants to exercise this privilege, since the patent was developed with federal money.

The opposing view holds that it is the government money that provides the seed funding to get that idea into the public domain. And this is true. But it is also true that the patent is exploited and this creates economic activity that in turn benefits the nation. It also directly benefits Uncle Sam through taxes on the profits made from the commercialization.

All of this leads to the basic conclusion that if Congress wants to have a faster spinoff of the applications work NASA does, a broad statute must be written that provides a method of getting that application to the private sector which, in turn, will bring it into commercial reality. The government, of course, should retain royalty-free use of the data.

Next, I would like to address NASA's role for space science over the next decade. Most of you have read in various articles that NASA has very few programs planned for the future and, moreover, this program area is an easy target for budget cutters, despite public and Congressional support. The planned programs we have, in fact, are as much as



New Rocket Concept—Under study at NASA's Marshall Space Flight Center, Huntsville, Ala., is an unmanned launch vehicle called the SRB-X, which would be developed primarily from recoverable Space Shuttle components. In a "mixed fleet" concept which NASA is considering, the SRB-X would be used to augment Shuttle flights when payload space is not immediately available in the Orbiter. The "SRB" refers to the Solid Rocket Booster, that part of the Shuttle system which provides primary thrust at launch and falls back to Earth for recovery. In this artist's concept, a three-rocket SRB-X configuration lifts off to carry as much as 65,000 pounds of cargo into low Earth orbit. The payload would be located at the top of the center rocket, and after the payload was inserted into orbit the solid rocket boosters would fall back to Earth to be used once again.

we currently can afford. I would like to do a lot more. But interestingly, and I've been staring at budget numbers here for the last couple of months, if you look at percentages and forget about the absolute amount, space science has been getting about the same percentage of the budget since the Apollo days.

Now the problem is, from the point of view of real resources, that is a declining number. The figures as they work out reveal a steady-state condition if you go back to 1972, the completion of our Apollo expenditures. We were spending a budget for a core program—on the order of $3.3 to $3.4 billion in 1971 or 1972 dollars. Escalating that into 1982 dollars equals $7.5 billion. Congress now is ready to enact a NASA budget of $6 billion, $1½ billion short of a steady-state core program. That's the reason the space science share of the total budget is a lot less than they were obtaining in 1972, and that hurts.

If the NASA budget is cut further, and I trust it won't be, we would definitely have to cut into the space science program, because there is no other place to cut. Our endeavor over the next five years is to get back to a NASA budget that is a little closer to the one percent of government expenditures. That's a percentage I think is reasonable and not greedy for this agency.

To achieve this, NASA needs a new major goal to provide the program of technology which stimulates so much spinoff. The reason I and the Deputy Administrator (Hans Mark) have emphasized a space station as such a goal follows naturally in the Shuttle program—the program envisioned was not only transportation but a total system. The space shuttle provides the ability to carry a lot of weight up and a revisit capability. This ability leads you to start thinking of applications which require large structures, antenna systems, materials processing systems, or large systems with potential for power generation.

When you start talking about large structures, you've got to carry them up in pieces and put them together in orbit. And when you start to examine how you're going to do that, you really need a base; hence a space station. Once you're there, then you can start dreaming even bigger dreams.

In contemplating these possibilities, you can start seeing a huge system involving manned activity in using the three planet system of the Earth, Moon and Mars. Now you're out to the year 2050 or something like that, but you've got a continuing series of objectives set, each of which leads logically to the next. And such an expansive program of manned activity will not draw away from the space sciences. There is still a long list of initiatives that we would like to achieve in space science. And when you get to the point of having the space station and the ensuing capability of doing things in space, then a lot of that science becomes easier to obtain. The system becomes more logical in terms of what you have to do in order to launch the platforms to the place you want.

I do not believe that the future of space shuttle operations necessitates a split between military and civilian shuttles. However, if the Air Force feels in any way that it needs a degree of control that they feel they don't have, I'd be perfectly willing to give it to them for their flights. But I would object very much to splitting the fleet. I think that there's a lot of advantages to keeping the fleet together, both operational, economic and from the point of view of the improvement of the system as we go along. The flight rate that the Air Force is talking about is relatively low, and there's no reason why we can't draw key people out of Kennedy to assist them.

We will need five orbiters to effectively carry out the productive utilization of space. Sooner or later we will have operational failure and need back up vehicles standing by when we reach a high flight rate per year.

In the long-term, NASA is not an operating agency. That troubles people when you look at the rate of shuttle activity that may develop: 25 or 30 flights a year, flying 2 or 3 times a month. A flight rate of that magnitude is a large operational responsibility. My experience in the federal government tells me that agencies with large operational responsibilities inevitably neglect their research and development responsibilities. Operational responsibilities are day to day. You've got to pay attention to them which necessitates devoting less and less time to research and development.

So in the future, when the shuttle achieves full operational capability, it will be something that can be spun off into either some kind of quasi-public/private corporation or operate as a profit-making enterprise.

As always, our goal must be to keep our constituency behind America's space program. We need this support to achieve our present and long range goals.

Note: This speech was taken from a recent interview given by NASA Administrator James M. Beggs to Dr. Mark Chartrand and Leonard David from the National Space Institute. The interview appeared in the Institute's November/December edition of *Insight* magazine.

1981 in Review

Two successful flights of the Space Shuttle Columbia, Voyager 2's flyby of Saturn and a perfect launch record were among the highlights of 1981 for NASA.

Columbia's two missions, in April and November, marked a new era in space flight. It was the first time that a spacecraft has been launched from and returned to Earth and then reused for a second mission.

More spectacular photographs and new detail and scientific data resulted from the closest approach to the giant ringed planet of Saturn by NASA's Voyager 2 spacecraft late in August.

The Voyager 2 mission added to information already gained about Saturn from Voyager 1 which flew past the planet in November 1980. Voyager 1 is moving out of the ecliptic plane of the solar system while Voyager 2 will travel several billion more miles to a Uranus encounter in January 1986, then on to a rendezvous with Neptune in August 1989.

In addition to the two Shuttle missions, there were 11 other successful launches by the agency. The year's perfect launch record is the fifth in the agency's 23-year history. The launches ranged from weather and communications satellites to environmental monitoring and Sun-Earth energy studies.

Following are synopses of NASA's program achievements for 1981. In this edition of *NASA Activities*, we will cover the reports for the Space Transportation System, Space Transportation Operations, Space Tracking and Data Acquisition, Aeronautics, and Energy Research and Development. In the February edition of *NASA Activities*, we will conclude these summary reports with the program areas of Space Science and Applications and International Affairs.

Space Transportation System

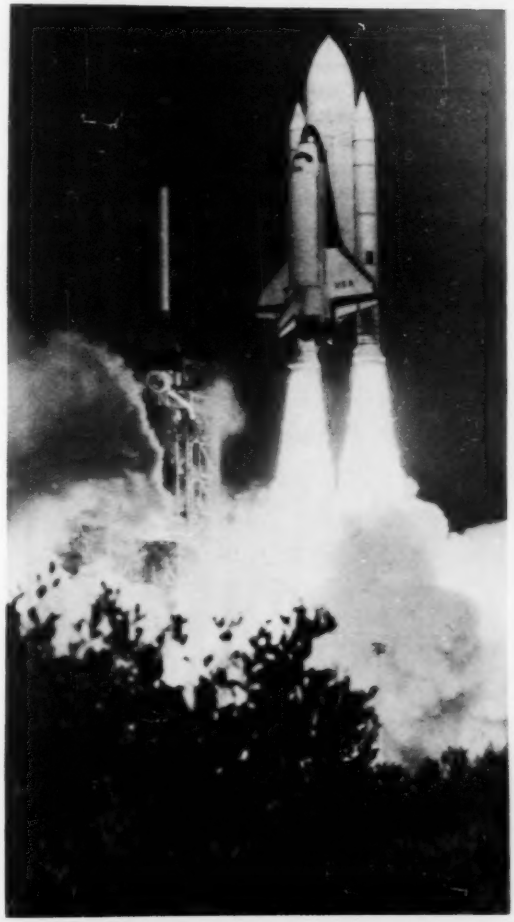
1981 was the year of the Shuttle. Two successful missions were conducted, in April and November, as the flight testing of the Space Shuttle, a key element in NASA's Space Transportation System, reached its halfway mark.

Astronauts John Young and Robert Crippen flew the Orbiter Columbia during its historic 54½-hour initial mission. The second flight, STS-2, carrying the first payload and the remote manipulator arm was manned by astronauts Joe Engle and Richard Truly.

The new era in manned space flight began April 12 at 8:00 a.m. EST, when the Space Shuttle roared off the launch pad at the Kennedy Space Center, Fla. The two-million-kilogram (four-and-a-half-million-pound) revolutionary spacecraft was thrust into space by a combination of two solid rocket boosters and a trio of liquid fuel Space Shuttle main engines.

Young and Crippen, during their two days in orbit, carried out a wide ranging series of systems checks to prove the feasibility of the Space Shuttle system.

During the flight, television cameras detected minor damage to the thermal protection system (TPS) tiles located on the orbital maneuvering system pods. The damage was not deemed serious.



First launch of the Space Shuttle Columbia, April 12, 1981.

At 10:21 a.m. PST, on April 14, the Columbia landed safely on Rogers Dry Lake at Edwards Air Force Base, Calif. The first Space Shuttle mission was determined to be an unqualified success.

The Columbia was returned to the Kennedy Center in a less spectacular way—piggybacked atop its 747 carrier aircraft.

STS-2, launched Nov. 12 from Kennedy Space Center, was significant in that it was the first time a spacecraft had been reused. Columbia, piloted by astronauts Joe Engle and Richard Truly, carried a space applications payload and a remote manipulator arm. It landed at Edwards on Nov. 14.

Despite a shortened mission, caused by a failed fuel cell, STS-2 was a success. Over 90 percent of the test objectives were completed by Engle and Truly and data from the OSTA-1 experiment package delighted investigators.

The Remote Manipulator System worked well and the thermal protection system again proved itself effective during the fiery entry through the Earth's atmosphere.

An investigation into the fuel cell failure began shortly after the orbiter was ferried back to the Kennedy Center from NASA's Dryden Flight Research Facility at Edwards.

Technicians at NASA's Kennedy Space Center's Orbiter Processing Facility remove the faulty fuel cell that shortened the second space shuttle mission to 54½ hours.

Within two weeks after landing, work began on readying the Columbia for its third flight test scheduled for March 1982.

Meanwhile, construction continued on the second orbiter, Challenger, at Rockwell International's plant at Palmdale, Calif. The newest orbiter is to be delivered to the Kennedy Space Center in mid-1982.

As orbiter construction proceeded, main engine testing continued at full power level (109 percent of rated power level) and external tank production maintained a steady pace.

As the Space Shuttle began to prove itself, a new study began on an unmanned launch vehicle based on solid rocket booster technology. SRB-X would be capable of boosting a 29,490-kg (65,000-lb.) payload into low Earth orbit or 5,443 kg (12,000 lb.) in geosynchronous orbit.

Space Transportation Operations

The successful flights of the Space Shuttle Columbia conducted in April and November paved the way for targeting the first operational STS launch (STS-5) for November 1982. Two more test flights are planned for March and July 1982.

STS users conferences held after each of the year's test flights briefed users on the results of both flights and the impact of each on future Shuttle planning. A new manifest calls for operational flight rates to build to 24 annually by 1988. The breakdown by fiscal year: 1983, 5 flights; 1984, 10; 1985, 13; 1986, 17; and 1987, 21 for a total of 66 operational flights through fiscal year 1987.

Early in 1981, the Air Force announced that Shuttle launch and landing facilities at Vandenberg Air Force Base, Calif., will not be ready until October 1985, a slip of one year from the previous planned operational readiness date. First flight from those facilities is a Department of Defense mission scheduled for October 1985. Eight launches are planned from Vandenberg through September 1987.

Delivery of the second Shuttle orbiter, Challenger, is scheduled for June 1982 with its first flight planned for January 1983. The third orbiter, Discovery, is scheduled for its first flight in January 1984. Delivery of the fourth orbiter, Atlantis, could be delayed up to a year depending on the outcome of current budget processes.

Nineteen new astronauts completed training in August, bringing the total flight-status astronaut corps to 79, including eight women.

Highlights from 1981 for the Office of Space Transportation Operations include:

• In December the European Space Agency (ESA) delivered to the United States the Spacelab module and pallet scheduled to make the first Spacelab flight aboard Shuttle in September 1983.

• The STS-2 flight in November carried the first Shuttle science payload. Known as OSTA-1, it consisted of Earth resources experiments and the pallet on which it was mounted was the first use of ESA developed Spacelab hardware.

• Final integration of the OSS-1 payload with its Spacelab pallet was completed in December for installation aboard the orbiter in early 1982. The payload is scheduled to fly aboard the STS-3 mission in March 1982 and will study space plasma physics and astronomy.

• Companies that might be interested in bidding on a future contract to do all Shuttle turnaround processing for NASA were invited to watch, at the Kennedy Space Center, Fla., the complete cycle of preparation of the Shuttle for its third flight.

• NASA and the West German firm Messerschmitt-Boelkow-Blohm GmbH (MBB) signed a launch services agreement for the first flight of the Shuttle Pallet Satellite (SPAS-01) currently scheduled for STS-7 in April 1983.

• Tentative plans were formulated for a possible retrieval and repair of the Solar Maximum Mission on the STS-11 mission in December 1983.

• Vought Corp., aerospace subsidiary of LTV Corp., Dallas, won a contract to continue production and launching of the Scout launch vehicle. Nine Scout launches are planned during the duration of the contract which is in effect from Nov. 1, 1981, through Oct. 31, 1984.

• McDonnell Douglas Astronautics Co., Huntington Beach, Calif., received a contract to build and launch an estimated 13 Delta launch vehicles over a two-year period beginning Oct. 1, 1981.

• Eleven satellite launches were conducted using Atlas Centaur, Scout, Delta and Atlas launch vehicles.

• Twelve expendable launch vehicle flights are scheduled for 1982.

Space Tracking and Data Acquisition

The Office of Space Tracking and Data Acquisition provides the vital electronic link between Earth and space for NASA's flight programs, including the Space Shuttle.

Its job is to keep track of where spacecraft are in orbit, tell them what to do, get information from them and process that information into a meaningful form. It does this primarily through two worldwide networks—one for deep space missions operated by the Jet Propulsion Laboratory, Pasadena, Calif., and the other for Earth-orbiting missions operated by the Goddard Space Flight Center, Greenbelt, Md. A global communications system called NASCOM ties the networks and various control centers together.

During the year, the networks supported an average of 25 flight missions daily. NASA's annual operating budget for its tracking and data acquisition functions is more than $400 million.

Highlights for 1981 included support of the first two orbital flight tests of the Space Shuttle Columbia in April and November, and the historic Voyager 2 flyby of Saturn in August. Space Shuttle mission support, among other things, enabled the world to see spectacular live television pictures from the Columbia in orbit.

Because of gaps in coverage during early Space Shuttle flights, temporary stations, primarily for voice communications, have been established at Dakar, Senegal; Gaborone, Botswana; Mahe, Seychelles Islands in the Indian Ocean; and Yarragadee in Western Australia. These stations will not be needed when the Tracking and Data Relay Satellite System is in place.

Work on integration and testing of the first Tracking and Data Relay Satellite continued at the TRW Systems Group, Redondo Beach, Calif. It is now scheduled for launch from the Space Shuttle in January 1983.

When this two-satellite, geosynchronous orbit system is in full operation, with its single ground terminal at White Sands, N.M., it will be the primary tracking and data acquisition system for the Space Shuttle as well as low Earth-orbiting satellites, eventually replacing ground stations of the Spaceflight Tracking and Data Network. Two stations of that network—Rosman, N.C., and Quito, Ecuador—were shut down during the year.

Finally, because of reductions in NASA's operating budget and the modestly declining workload of the three-station Deep Space Network, the 26-m (85-ft.) tracking antennas at Goldstone, Calif.; Madrid, Spain; and Canberra, Australia, ceased operations on Dec. 1. The stations will continue to operate 64-m (210-ft.) and 34-m (112-ft.) deep space tracking antennas as in the past.

Aeronautics

As the U.S. agency primarily responsible for advancing aeronautical science and technology, NASA conducts the research to maintain U.S. leadership in

the world air transport market and preeminence in military aeronautics. The main NASA aeronautics centers are: Ames Research Center, Mountain View, Calif.; Langley Research Center, Hampton, Va; and Lewis Research Center, Cleveland.

In 1981, NASA continued development of advanced technologies that could reduce fuel consumption in future commercial transport aircraft by as much as 50 percent. Elements of the research effort included turbine-driven fan jets and advanced turbine-driven propellers, computerized flight control systems, stronger and lighter weight structures and materials, and more aerodynamically efficient configurations.

The Energy Efficient Engine program element highlighted these efforts in 1981. Performance goals were demonstrated with various engine components, with the technology developed providing fuel savings in advanced turbine-driven fan engines of up to 20 percent over today's most efficient engines.

Teamed with the Federal Aviation Administration and industry, NASA tested advanced technology to enhance safety and efficiency in the crowded airspace around airports and under adverse weather conditions. These continuing efforts include aircraft ice protection concepts, fire resistant materials, aircraft crash dynamics, anti-misting fuel, lightning research, and advanced technology flight management systems and flight procedures.

The NASA/Army tilt rotor research aircraft, a promising concept for future civil and military applications, completed the proof-of-concept flight research phase this year. The aircraft combines the vertical lift, hover and maneuverability advantages of the helicopter with the greater forward speed of the fixed-wing aircraft. It flew about twice as fast and twice as far as a helicopter on an equal amount of fuel, achieving a top speed of 557 kilometers (346 miles) per hour. Flight demonstrations of this concept are planned for potential military and civilian users.

Maneuverability of a high speed fighter aircraft is one of its most critical elements. NASA and the Air Force are demonstrating a number of advanced technologies in a single research aircraft called HiMAT—for Highly Maneuverable Aircraft Tech-

NASA's HIMAT (for Highly Maneuverable Aircraft Technology), a remotely piloted research vehicle that allows high-risk flight testing without risk to pilots.

nology— which could double the maneuverability of future U.S. fighters. This year the research aircraft has expanded its flight testing to high transonic speeds, achieving over 7 g's maneuver load factor.

NASA's swing-wing research aircraft completed its flight program, demonstrating aircraft handling qualities at subsonic speeds with its wing angled, fore and aft, up to 60 degrees to its fuselage. Aeronautical theory indicates that such an oblique wing aircraft could fly at low supersonic speeds using less fuel and with no sonic boom audible on the ground. The wing is returned to the conventional position for efficient, quiet, low speed flight and for takeoff and landing operations.

NASA's Quiet Short-Haul Research Aircraft, demonstrating advanced aeronautical technologies aimed at solutions to airport congestion and noise problems, completed a flight evaluation series this year. Government, military, airline and industry pilots flew the research aircraft to evaluate its propulsive-lift technology. The aircraft's engine exhaust is directed over the wing surfaces to substantially increase lift, permitting quiet takeoffs and landings from short runways of smaller, closer-to-city airports.

NASA intentionally guided a modified F-106B jet fighter through severe southwest thunderstorms this year to study how lightning affects aircraft in flight. This and other basic knowledge about lightning is important to help safeguard future aircraft against a lightning strike. These efforts are a part of NASA storm hazard research, which includes studies of air turbulence, wind shear and storm hazards correlation.

Safety, energy efficiency and utilization of general aviation and commuter aircraft were emphasized in NASA research and technology efforts this year.

Acceptance flight tests of an advanced concept in aircraft flight control, navigation and flight management were completed. The system uses modern digital electronics, shared displays and modular concepts to achieve fault tolerance and increased reliability at potentially low cost. This system is being demonstrated in a NASA Cessna 402B aircraft.

Winglets, small structures attached almost perpendicular to wingtip surfaces, were developed by NASA as a means to reduce fuel consumption by lessening the effect of drag-producing vortices, the swirls of air that form at the aircraft wingtips. Similar winglets were tested on an agricultural aircraft in an attempt to make these vortices aid agricultural aerial applications.

NASA and the FAA are studying the crash dynamics of light planes, including the energy-absorbing characteristics of aircraft subflooring. By redesigning the interior floor, researchers are attempting to reduce the crash forces that can be transmitted to people inside the plane. Other research is aimed at improving the energy-absorption characteristics of aircraft seats and restraint systems.

This research on crash dynamics is being expanded to jet transports and will complement current NASA/FAA research aimed at enhancing occupant survivability in post-crash fires.

In aerodynamics research, important strides were made in the use of high-speed computers to predict aircraft aerodynamic behavior. An algorithm was discovered that permits a 10-fold increase in computational speed and in calculating forces and flow velocities over aircraft wings and bodies. The method introduces a procedure permitting time steps in the computations that would normally produce instability and lack of convergence in the computation. The new procedure has been independently checked and is being adopted by researchers all over the world.

In propulsion, research on alternate hydrocarbon gas turbine fuels for aviation focused on fuel property characterization and combustor concepts for engines typical of commercial transport and commuter applications that minimize the impact of operating with poorer quality fuels that might be expected from oil shale or coal derived fuels in the future. Research results have shown that poorer quality fuels, lower in hydrogen content, result in significant increases in engine combustor liner temperatures and moderate increases in exhaust emission levels for current production combustor configurations. The advanced concepts, such as multistage combustion, have demonstrated a much lower sensitivity to fuel quality changes.

In aviation electronics, modern flight control system designs employing digital computers incorporate an independent backup computer system to preclude the simultaneous loss of all control channels. This approach increases the overall system complexity and cost. Recent research in controls has focused on the development of a technique of embedding backup software within the primary control system computers, thus eliminating the need for any additional hardware. Such software would be independently generated and called upon when a generic software anomaly occurred. Laboratory tests have demonstrated the effectiveness of this technique in reducing the cost and complexity of future digital flight control systems.

Artist's concept of the world's largest highest-capacity wind turbine installation, a three unit 7.5 million watt system located in Goodnoe Hills, Washington.

Energy Research and Development

NASA energy research, development and demonstration efforts, sponsored by the Department of Energy and other agencies, made significant contributions during the year toward advancing technologies to meet national energy needs.

A first generation, experimental, advanced gas turbine automobile engine was assembled to verify turbine aerodynamic efficiency advances and to continue development of ceramic components, the key technology needed to raise engine operating temperatures to engine efficiency goals.

Test of the first, intermediate temperature experimental Stirling engine demonstrated efficiencies equal to automotive diesel engines and emissions less than Environmental Protection Agency research goals.

First experimental ac electric vehicle propulsion system tests demonstrated an overall efficiency of 82 percent, equaling dc systems. With further development, both systems hold promise for improved performance and lower initial cost of an electric car.

Solar cell electric system technology advancements, this year, included improved methods for purifying silicon and for producing thin silicon sheets by ribbon crystal growth processes. Encapsulation system designs were developed and automation in assembly of cells into encapsulated modules was demonstrated. This process is consistent with program goals of providing technologies for cost-effective solar-cell electric systems in this decade.

Three large wind turbine electric generators began operation in 1981, bringing the total constructed to nine since program initiation in 1973. These latest machines are advanced designs installed at Goodnoe Hills, Wash., each providing 2.5 million watts to the power grid. Each of the three units in this first U.S. "wind farm" has 91-meter (300-foot) diameter blades. It is estimated that production versions of these machines could provide electric power for about 5 cents per kilowatt-hour, a price competitive with conventional power in many U.S. areas. Conceptual designs were completed on larger wind turbines that could produce power for about 3 cents per kilowatt-hour. These designs have rotor blades 122 m (400 ft.) in diameter and would produce 5 to 7 million watts.

Over 7,000 test hours have been accumulated on the first multi-kilowatt phosphoric acid fuel cell power plant being developed for on-site commercial/residential applications. An improved short cell stack configuration was tested for more than 5,000 hours at an operating pressure and temperature required for multi-megawatt utility applications. The latter configuration promises reduced overall system cost by at least 20 percent and an extended electrolyte inventory of 40,000 hours. An alternative air-cooled cell stack concept is also being investigated which holds the potential for system design simplicity and enchanced reliability.

New Key Personnel at NASA Headquarters

NASA Headquarters begins the new year with a host of new personnel in key positions: Comptroller, Deputy General Counsel for Policy Review, Associate Deputy Administrator, Associate Administrator for the Office of Space Transportation Systems, and Associate Administrator for Management.

C. Thomas Newman has been named NASA's **Comptroller**, replacing William E. Lilly who retired in October. Newman had been serving as acting Comptroller since Lilly's retirement. As Comptroller, Newman will direct and implement NASA's budget formulation and execution process and will provide the agency-wide financial control required to assure adequate, timely and essential accounting of all agency resources.

Robert F. Allnutt, NASA Associate Deputy Administrator since mid-1978, has been named **Deputy General Counsel for Policy Review.** In this position, he will be responsible for a series of reviews of the legal implications of major NASA policy areas.

Philip E. Culbertson replaced Allnutt as **Associate Deputy Administrator.** Culbertson will, as a special assignment, direct NASA planning for the development and operation of a U.S. Earth-orbiting platform or station capable of evolutionary growth to a facility which could support intermittent or long-term human habitation. Previously Culbertson had served as NASA's Assistant for Space Transportation Systems since 1979.

Major General James A. Abrahamson has been named **Associate Administrator for NASA's Office of Space Transportation Systems** where he will head Space Shuttle development. He is on assignment from the Air Force where he serves as deputy chief of staff for systems, Headquarters Air Force Systems Command at Andrews Air Force Base, Md. Abrahamson succeeds John F. Yardley who left NASA in May 1981 to become president of McDonnell Douglas Astronautics Co., St. Louis, Mo.

Dr. Walter B. Olstad is NASA's new **Associate Administrator for Management**, replacing Edwin C. Kilgore who retired in October. Olstad had served as Deputy Associate Administrator for Aeronautics and Space Technology since 1979. In this new position, Olstad will provide managerial direction involving all functional management and administrative matters such as personnel, supply and equipment, facilities and computer support. He will also provide managerial advice and support to Program Associate Administrators, the Deputy Administrator and the Administrator. The Office of Management was created under the NASA reorganization plan which became effective in November. This new office will handle part of the functions previously performed by the Office of Management Operations and some of the functions under the NASA Comptroller.

Third Shuttle Crew Selected

Jack R. Lousma and Charles G. Fullerton have been selected by NASA as commander and pilot, respectively, for the third flight of the Space Shuttle, Columbia. Backup crew will be Thomas K. Mattingly II, and Henry W. Hartsfield, Jr.

Lousma, a U.S. Marine Corps colonel, is a veteran of Skylab 3, July-September 1973. As mission pilot, he logged over 1,427 hours in space during which he and his fellow crewmembers accomplished 150 percent of preassigned goals.

Fullerton, an Air Force colonel, was assigned as pilot of the Space Shuttle *Enterprise* on the first, third and fifth flights in the Approach and Landing Test Series in 1977, when the vehicle was separated from the back of its 747 carrier aircraft and flown to a landing at Edwards Air Force Base, Calif.

STS-3 Crew in Simulator—Prime crew for the third flight of the Space Shuttle Columbia undergo training in the orbiter simulator at NASA's Johnson Space Center, Houston. Astronaut Jack R. Lousma (left) will be commander of the third Shuttle mission; astronaut Gordon Fullerton (right) will serve as pilot.

European Space Agency Delivers Spacelab For U.S. Shuttle

The major components of Spacelab—Europe's contribution to the NASA Space Transportation System—were shipped to the United States from West Germany aboard a U.S. Air Force transport the week of Dec. 6; the components arrived on Dec. 11 at NASA's Kennedy Space Center, Fla.

Spacelab is being developed and built under the aegis of the European Space Agency (ESA) by a European industrial consortium under the leadership of the West German firm ERNO Raumfahrttechnik GMBH. It consists of a habitable module and several unpressurized experiment support structures called "pallets." When placed inside the cargo bay of the Shuttle orbiter, Spacelab components will convert the Shuttle into a versatile on-orbit, scientific research center for both astronauts and civilian scientists.

The module and one pallet that will be used for the first Spacelab flight, which will be a joint U.S./European mission in September 1983, were among the components shipped to Kennedy.

The laboratory was formally delivered to NASA at a ceremony on Dec. 4 at the ERNO facilities in Bremen, West Germany. It was then transported overland to Hanover where it was readied for flight to the United States aboard an Air Force C5 Galaxy.

NASA's Marshall Space Flight Center, Huntsville, Ala., has prime NASA responsibility for Spacelab's procurement and operation and will manage its first three scientific missions. The laboratory will be prepared for flight and installed on the Space Shuttle at Kennedy Space Center. The Marshall Center is also responsible for developing and providing some additional associated components and computer software. NASA is purchasing a second flight unit for approximately $300 million. Delivery of the second Spacelab is due to be completed by 1984.

Acceptance and delivery of Spacelab marks a major milestone in a historic program of European-American space cooperation. Under ESA's nearly $1 billion Spacelab development program, which began in 1973, the 10 participating European states are supplying an engineering model and flight version of the laboratory, associated ground support equipment and some computer software—all at no cost to NASA. They will also provide 50 percent of the payload to be flown on the first mission.

Student-Developed Shuttle Experiments Receive Sponsors

Three student-developed experiments have received private-sector sponsorship to fly aboard an early Shuttle flight. Two of the projects received sponsorship as Get Away Special payloads; the other is designed to be flown in the orbiter mid-deck locker.

Get Away Specials are small self-contained payloads that will be flown in the cargo bay of the orbiter on a space available basis on operational flights. They are privately funded, small scientific research and development projects provided by a wide variety of users. They are limited to 200 pounds, cannot occupy over five cubic feet of space and do not require any special servicing. To date NASA has accepted 321 Get Away Specials to be flown on a space-available basis with major scheduled payloads beginning with the fifth Space Shuttle flight in 1982.

RCA Corp., Cherry Hill, N.J. has agreed to sponsor a student experiment as a Get Away Special. The project, to study the effects of weightlessness on a colony of carpenter ants, was presented to RCA engineers in October by students representing two high schools in Camden, N.J.—Camden and Woodrow Wilson.

Known as Orbit 81, the project is a cooperative effort between the high schools. It started in 1978 as part of an ongoing RCA objective to interest minority students in engineering careers.

The students chose a carpenter ant colony as the subject of their experiment because the insects have hard skeletons to withstand the rigors of launch and a social structure that might be affected by weightlessness. They plan to take photographs and movies of the colony while it experiences the gravity-free environment of space aboard the Shuttle. To control the temperature within the canister and operate cameras and their lighting, the students have programmed a microprocessor chip.

If students can meet their self-imposed timetable for constructing the ants' sealed container, it will be ready by mid-February.

The Asahi Shimbun, one of Japan's major daily newspapers also has recently signed an agreement with NASA to fly a Get Away Special. The experiment, suggested by two Japanese high school students, will use the near weightlessness of space to make artificial snow crystals directly from a gaseous substance while the Space Shuttle is in orbit.

Students from two New Jersey high schools examine a colony of carpenter ants as part of Orbit 81, a student-developed project designed to put ants into space aboard the Space Shuttle. Orbit 81 will test the effects of weightlessness on the colony. RCA Corp., Cherry Hill, N.J., will sponsor the experiment as a Get Away Special payload aboard an early Shuttle flight.

The experiment is expected to contribute significantly to crystallography, especially the crystal growth of semi-conductors or other materials from a vapor source. It will be the first to make artificial snow in a weightless environment. Historically, the first artificial snow-crystal experiments were made by a Japanese physicist, the late Dr. Ukichiro Nakaya, in 1936. Since then a variety of follow-on snow experiments have been carried out by Japanese scientists.

Honeywell Inc., Avionics Division, Minneapolis, Minn., has announced it will sponsor the space shuttle experiment of 17-year old Minnesotan, Todd Nelson, one of 10 winners in the first (1981) student science project competition sponsored jointly by NASA and the National Science Teachers Association.

Todd's experiment deals with aerodynamics in zero gravity; that subject is of interest to Honeywell because they are a major supplier of avionics systems for commercial, military and space applications.

Todd is a senior at Southland High School in Elkton, Minn. The experiment he wrote proposes high speed photography of flying insects in zero gravity to determine what orientation and flight problems are encountered and how the insects adapt aerodynamically to solve those problems.

For the experiment, a collapsible container stowed in the mid-deck locker of the Shuttle would carry a number of flying insects into space. During flight the astronauts would open the locker, expand the container, observe and photograph the insects flying in zero gravity. Those observations and films would be analyzed on Earth. The information gained from this and future experiments will help scientists in the design and construction of space colonies and apparatus used by space colonists for work, travel and recreation.

Honeywell has assigned two engineers to assist Todd; they will help him take the experiment from design to fabrication, to on-earth control experimentation and finally onboard a future flight of the Shuttle.

NASA Observatory Re-enters Atmosphere

HEAO-3, NASA's third and last in a series of High Energy Astronomy Observatories launched into space in the late 1970s, fell from orbit December 7 and burned up harmlessly in the atmosphere, according to NASA's Marshall Space Flight Center, Huntsville, Ala., which managed the HEAO series.

The first observatory, HEAO-1, re-entered the Earth's atmosphere and was destroyed in 1979. HEAO-2, nicknamed the "Einstein Observatory," is still in orbit but no longer operational. It is expected to re-enter the atmosphere and burn up by spring of 1982.

Launched in September 1979, HEAO-3 was designed to scan the heavens to further knowledge about cosmic and gamma rays, the two highest energy radiations in the universe. Although the observatory was designed for a mission life of six months, it continued to provide data until June 1981. At that time, HEAO-3 had expended the last of its thruster gases used for attitude control, and the observatory was powered down.

The mission of HEAO-3 differed from its predecessors, HEAO-1 and -2, which were designed to study X-rays. The information gathered by HEAO-3 about cosmic and gamma rays has extended the scientific world's knowledge about these mysterious radiations from deep space.

Through the study of cosmic rays, which are the nuclei of any given element and the highest energy particles known, HEAO-3 measured the relative

abundance of elements in the cosmos. The observatory found unexpected differences between these amounts and the relative abundance of elements in the solar system.

Gamma rays, higher on the energy spectrum than X-rays, are emitted from galactic sources which may be unobservable to visible light telescopes. Gamma ray studies from HEAO-3 shed further knowledge about such astronomical question marks as black holes, pulsars, quasars, and supernovas.

"Flying Research Facility" Inaugurated as New NASA Research Tool

A "flying research facility," designed specifically to study advanced helicopter rotor systems under actual flight conditions, was recently inaugurated at NASA's Ames Research Center, Mountain View, Calif. The Rotor Systems Research Aircraft (RSRA), on its first NASA-piloted flight test, flew over San Francisco Bay at speeds up to 120 knots (138 miles per hour) for 45 minutes.

On its maiden research flight, the helicopter-type aircraft also was equipped with fixed wings and jet engines which will provide a portion of the needed lift for the study of helicopter rotors too small to support the research aircraft alone.

For the initial test phase, the rotor is the same type used on presidential helicopters—providing a highly reliable rotor for these first flights. Ames' Warren Hall piloted this first flight for NASA. The co-pilot was Lt. Col. Bob Merrill, deputy director of the U.S. Army flight test activity at Edwards Air Force Base, Calif. A second RSRA aircraft has been flown at Ames in the basic helicopter configuration.

The two RSRA aircraft, funded by NASA and the U.S. Army, are located at Ames to provide a national facility for in-flight investigation and verification of new helicopter rotor system concepts and technology. They can be flown as a helicopter or can be equipped with the fixed wings and auxiliary jet engines to enhance the vehicles' test capability.

Research programs will be aimed at increasing rotor aircraft speed, performance, reliability and safety, as well as reducing helicopter noise, vibration and maintenance.

In the current helicopter configuration, the RSRA utilizes a Sikorsky S-61 rotor and a drive system consisting of two T-58-GE-5 turboshaft engines, the main transmission, the 19-meter (62-foot) diameter main rotor, tail takeoff drive shaft, intermediate gear box, tail gear box and the 3.35-m (11-ft.) diameter tail rotor. The horizontal stabilizer is a "T"-tail with a 4.04-m (13.25-ft.) span.

In the compound configuration, a wing and two auxiliary jet engines are added and the tail is modified with the addition of a 6.86-m (22.5-ft.) span stabilator (stabilizer-elevator) and a rudder and associated controls. The wing has a 13.7-m (45-ft.) span and includes both aileron and flap surfaces. The two auxiliary jet engines are TF-34-GE-400A high-bypass-ratio turbofans with maximum rated static thrust of 4,207 kilograms (9,275 pounds) each.

The two RSRA aircraft were originally built by Sikorsky Aircraft Division of United Technologies Corp. for NASA's Langley Research Center, Hampton, Va., and the U.S. Army Research and Technology Laboratories with headquarters at Moffett Field, Calif. The two aircraft were transferred to Ames Research Center in 1979 for the joint flight research program by Ames and the Army.

Rotor Systems Research Aircraft in flight at NASA's Ames Research Center, Mountain View, Calif. The RSRA is a research aircraft funded by NASA and the Army that is both a helicopter and a fixed wing flying test bed. Two of these aircraft have been built for the government by Sikorsky Aircraft Division of United Technologies Corporation.

NASA Headquarters Reorganizes

NASA Headquarters underwent a structural and line-of-command reorganization in November. Changes included the combination of the Office of Space Science and the Office of Space and Terrestrial Applications into a new Office of Space Science and Applications and the establishment of an Office of Management which will handle a part of the functions now performed by the Office of Management Operations and some of the functions presently under the NASA Comptroller. The Office of Management will support the program offices in the management of research and development and institutional resources.

Under the reorganization, program office Associate Administrators will be the major line officers of NASA and the NASA Center Directors will report to Headquarters through these individuals as follows:

Jet Propulsion Laboratory, Pasadena, Calif., and Goddard Space Flight Center, Greenbelt, Md., will report to the Associate Administrator for Space Science and Applications;

Ames Research Center, Mountain View, Calif., Langley Research Center, Hampton, Va., and Lewis Research Center, Cleveland, will report to the Associate Administrator for Aeronautics and Space Technology; and

Johnson Space Center, Houston, Kennedy Space Center, Fla., Marshall Space Flight Center, Huntsville, Ala., and the National Space Technology Laboratories, Bay St. Louis, Miss., will report to the Associate Administrator for Space Transportation Systems.

NASA Administrator James M. Beggs said of the reorganization: "The specific goals of the new organization are to assure the proper delegation of authority to all line managers, set forth a clear distinction between line and staff and a simplification and clarification of field centers' reporting lines."

"Convertible" Engine May Offer Combined Helicopter-Aircraft Features

A revolutionary engine concept that could enable aircraft to maneuver like helicopters but attain cruising speeds of fast air transports using its helicopter rotor blades as fixed wings, is being studied by the Defense Advanced Research Projects Agency and NASA.

Essential to the new concept would be development of a convertible engine allowing the plane's turbofan engines to convert from the conventional, forward-thrusting mode to a mode that imparts torque to the shaft that drives the plane's horizontal rotor blades and back again.

The engine is "convertible" in the sense that it can operate as a turbofan engine by disengaging the rotor, as a turboshaft engine driving the rotor in the helicopter mode, or in both modes simultaneously. A sophisticated digital electronic system would be used to control the vehicle throughout all modes of operation.

In operation, the projected craft would take off vertically through the use of a lifting rotor. When it achieved desired altitude and forward speed, the engine would convert from powering the rotor to a forward thrust, turbofan, mode. The transmission would be disengaged and the rotor blade locked into a fixed position, their airfoil configuration imparting conventional lift to the plane for forward, level flight. Conversion from shaft power to forward thrust would take about 15 to 20 seconds.

NASA's Lewis Research Center, Cleveland, indicates such a craft could be ready for experimental

Familiar Pilot—Sen. Barry Goldwater, R-Ariz., recently flew the Tilt Rotor Research Aircraft at Bell Helicopter Textron's Flight Research Center in Arlington, Texas. The Tilt Rotor Research Aircraft, a joint NASA/Army/Bell project, is capable of taking off like a helicopter and flying like an airplane. During the 45-minute flight, Goldwater made numerous takeoffs and landings as well as transitions to and from the airplane mode. The senator was accompanied by Bell test pilot Dorman Cannon.

flight testing in the mid 1980s and recently awarded a contract to General Electric Co., Lynn, Mass., to proceed with the engine test program to provide the basic technology for future concepts.

The powerplant selected for the convertible engine ground-test program is General Electric's TF-34 turbofan engine, now operational on U.S. Air Force and Navy planes with nearly one million hours of flight time.

Aeronautics research is a focus of work done at several NASA facilities: Ames Research Center, Mountain View, Calif.; Dryden Flight Research Facility, Edwards, Calif.; Langley Research Center, Hampton, Va.; and Lewis.

Specific mission of the project is to provide a research tool, a specially modified turbofan engine, to determine feasibility of the convertible engine concept with an automated control system.

Such an aircraft concept would represent a significant technical advance over vertical takeoff and landing planes now in service and provide a potential major breakthrough in the building and operation of such vehicles.

Some exploratory research aircraft have utilized separate powerplants for vertical flight and forward flight, or propulsion systems that must be physically redirected for either vertical or level flight.

The convertible engine concept eliminates much of the extra weight and expense of installing two separate powerplants to handle vertical and horizontal flight functions. This concept consists of a normal turbofan engine in combination with a fan shaft to drive the rotor through a transmission system.

Under the $5.6-million contract awarded by Lewis, General Electric will design and fabricate a converted TF-34, and deliver the modified engine to Lewis for a year-long testing and evaluation program. The engine testing project is planned for completion by late 1984.

The project is funded jointly by NASA and the Defense Advanced Research Projects Agency (DARPA). DARPA is a part of the Department of Defense and provides advanced research for the nation's military services.

Spacelab 1 Payload Specialist Reassigned

The European Space Agency has announced that one of three European payload specialists who had been preparing for the first flight of the NASA/European Spacelab in 1983 has been reassigned to other duties.

Dr. Claude Nicollier of Switzerland was one of five scientists picked in 1978 to operate the experi-

White House Honorees—The astronaut crew of the second Space Shuttle mission, commander Joe Engle and pilot Dick Truly, were recent recipients of the NASA Distinguished Service Medal at ceremonies held in the oval office of the White House. They received this award on Dec. 7, 1981, a date that also marks the 40th anniversary of the bombing of Pearl Harbor. From left to right are: STS-2 pilot Richard Truly; Cody Truly; President Reagan; Mary Engle; STS-2 Commander Joe Engle; NASA Administrator James M. Beggs; NASA Deputy Administrator Hans Mark; and NASA's White House liaison, James Fanseen.

ment equipment aboard Spacelab 1. He and fellow Europeans Dr. Wubbo Ockels and Dr. Ulf Merbold, together with American scientists Dr. Michael Lampton and Dr. Byron Lichtenberg, began a one-year hiatus from this training in summer 1980 because of a delay in the launch date. During this pause, Nicollier and Ockels underwent NASA astronaut mission specialist training at the Johnson Space Center in Houston.

While Spacelab training has resumed, the European Space Agency announced that it would leave Nicollier at Johnson to continue his training as mission specialist with a view to obtaining full capacity in this field for future Shuttle missions carrying European payloads. Ockels and Merbold will continue Spacelab training along with the two Americans. One American and one European will eventually be identified to fly. The other two payload specialists will operate ground-based equipment and support the pair on orbit.

Spacelab 1 is to be a joint American-European mission using the European-built Spacelab facility aboard a NASA Space Shuttle. The first three missions are being managed by NASA's Marshall Space Flight Center, Huntsville, Ala., which is responsible for payload specialist training.

Small Tail in Front May Make Light Planes Safer

Researchers at NASA's Langley Research Center, trying to enhance flight safety, are helping to make light planes inherently stall and spin-resistant.

Aircraft safety and efficiency is the focus of work at Langley and NASA's other leading aeronautical facilities—Ames Research Center, Mountain View, Calif.; Dryden Flight Research Facility, Edwards, Calif.; and Lewis Research Center, Cleveland.

During the past decade, more than 100,000 Americans were involved in more than 39,000 light plane accidents, according to a recent report by the National Transportation Safety Board. Nearly one in four of those accidents are believed to have been due to loss of control after the planes were either purposely or accidentally maneuvered into a stall or spin. One promising development in stall and spin prevention research is the rediscovery of the canard—a miniature wing that sprouts from the aircraft nose area.

The canard is the most recent focus of a NASA research program aimed at making light planes safer. Joe Chambers, assistant chief of Langley's Low-Speed Aerodynamics Division, strongly believes that " the aircraft tail-first, canard configuration is the shape of light planes for the 1990s."

The potential advantages of some of these far-out looking canard-configuration aircraft are very promising, both in terms of safety and efficiency. The canard was first proven effective by the Wright brothers at the turn of the century. Since then, it has been largely neglected due to early patent considerations and occasional flight handling problems.

The rebirth of the canard is being hastened by the booming market in homebuilt airplanes. Several designer-manufacturers are selling airplane kits to the public that include this forward, horizontal wing surface, in part because of fuel efficiency.

A demonstrated safety advantage, however, is what intrigued Langley researchers when they approached the designer of the VariEze, a novel-looking home-built airplane with canard, no horizontal tail, and a rear propeller engine. Constructed and flown by more than 400 kit builders in the United States, this two-seater (and others similar to it) have amassed an impressive stall-spin safety record.

A stall—loss of wing lift and, thereby, loss of aircraft control—generally occurs at low speeds and at certain flight altitudes, though stall can occur at any speed with gross and abrupt control inputs. A stall can cause a plane to veer sharply off course and out of control into a spin. Spins in some airplanes are unrecoverable.

Tests of a VariEze scale model in Langley's Spin Tunnel confirmed that, properly "loaded," the plane is virtually impossible to spin.

Its unique configuration, a combination of canard and narrow, swept main wing with vertical "winglets" at the wing tips, has a built-in resistance to aircraft stalling or spinning. Winglets, an invention of Langley's Dr. Richard Whitcomb, have already proven to be a fuel-efficient concept.

Another series of tests, however, revealed a problem already experienced by several VariEze owners under certain specific conditions that can result in a lateral stability problem. In "free-flight" tests in Langley's 9-by-18-meter (30-by-60-foot) Wind Tunnel, at low speeds and with the nose high, a model flew with a violent rolling oscillation, or wing rock. After study, researchers solved the problem with a simple modification of the main wing. Burt Rutan, the creator of the VariEze, immediately conducted a full-scale flight test with a modified wing, found it

had indeed solved the problem and promptly recommended the change to all VariEze owners.

The last phase of wing tunnel testing planned for the VariEze has recently been completed in the wind tunnel. A full-scale VariEze, built in Langley's model shop, contributed detailed data about the complicated relationship of canard and wing placement, and their thickness and shape.

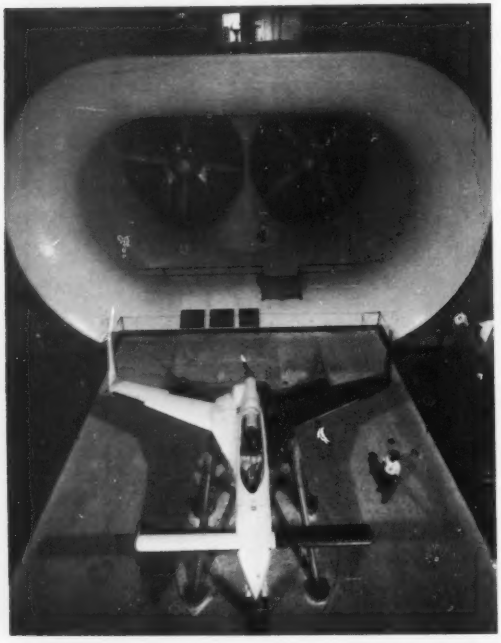
"We're also correlating this experimental wind tunnel work," Chambers says, "with computer codes to predict flight characteristics and hope, ultimately, to end up with a 'cookbook' for designers which can be used to quickly and easily design advanced configurations."

Another reason for the tests is to document the airplane's aerodynamic efficiency—which is considerable—without specifically trying to improve it. The airplane is exceptionally streamlined and lightweight, making use of foam sections covered with a seamless, lightweight composite material much like fiberglass. Advanced construction techniques is another area NASA will investigate in its light plane research.

The VariEze tests began more than two years ago when Langley research pilots Jim Patton and Phil Brown put the plane through its paces at the designer's facility in the Mojave Desert.

One negative characteristic obvious to anyone who has flown the plane is that the canard is attached in a position that somewhat reduces pilot visibility during takeoff and landing. VariEze wind tunnel data, still being analyzed, is expected to determine whether the canard can be placed lower on the fuselage, more out of the pilot's sight, without sacrificing its excellent flight safety qualities.

NASA plans to continue tests with twin-engine versions of the VariEze configuration and other unusual canard designs, including possible canard application to larger aircraft such as commuters.



NASA's VariEze research aircraft undergoing wind tunnel testing at NASA's Langley Research Center, Hampton, Va.

Spacelab 1 Crew Receive Training in Japan

Spacelab's six-member payload crew went to Japan in December to train to operate a group of instruments scheduled to fly on the first mission of the spaceborne research facility in 1983.

These instruments, used in an investigation called Space Experiments with Particle Accelerators are designed to help scientists gain an understanding of the Earth's magnetosphere and how it interacts with the upper atmosphere. The magnetosphere is an envelope of magnetic fields and charged particles that surrounds the planet. Principal investigator for the NASA-sponsored experiment package is Professor Tatsuzo Obayashi of the University of Tokyo.

The crew underwent several days of classroom training and practiced operating the actual flight experiment hardware which is installed in a vacuum chamber at Japan's National Space Development Agency on the outskirts of Tokyo.

The payload crew for the first Spacelab mission—a joint NASA/European Space Agency mission—consists of four civilian scientists called payload specialists and two NASA mission specialist astronauts. They are Drs. Byron Lichtenberg and Michael Lampton of the United States, Drs. Ulf Merbold of West Germany and Wubbo Ockels of the Netherlands, payload specialists; and Drs. Owen Garriott and Robert Parker, mission specialists. Two of the payload specialists will actually fly aboard the mission with the two mission specialists, and two will support the mission from the ground.

NASA's Marshall Space Flight Center, Huntsville, Ala., is responsible for managing the first three Spacelab missions.

Did You Know?

An exhibit of twenty-eight works of art documenting the development of the Space Shuttle project closed Jan. 4 after 10 weeks on display at the Smithsonian's National Air and Space Museum, Washington, D.C. The exhibition featured drawings, watercolors, gouaches, acrylics and oils, each artistically depicting various aspects of the Space Shuttle project from early tests in 1977 to the first launch of "Columbia" on April 12, 1981. Among the American artists and illustrators represented in the exhibition were Arthur Shilstone, Robert McCall, Charles Schmidt, Maria Epes and James Dean. The artists' impressions of this new era of manned space flight varied. Some chose to emphasize the technological complexity of the spacecraft while others were intrigued with capturing technicians at work on various stages of construction. The exhibition was prepared by the Museum in coordination with NASA. For more than 18 years, NASA has commissioned artists to render their impressions of key events in the United States space program. The works in the exhibition are only a portion of NASA's collection of Space Shuttle art.

National Space Technology Laboratories' Visitors Center recently reached two important milestones: its first anniversary and registering its 50,000th visitor since the Center opened Nov. 19, 1980. The figure represents an increase of more than 33,000 visitors over the previous year. Since its opening a year ago with expanded hours of operation, people from all 50 states and 56 foreign countries have registered at the Center. Among the visitors were Space Shuttle astronauts John Young and Robert Crippen who cut the ribbon May 8 to officially open the Center.

Idea Clearinghouse this month cites NASA's Jet Propulsion Laboratory, Pasadena, Calif., for using a conventional 35 mm microfilm system to transfer large quantities of technical documents to prospective contract bidders. JPL has found that reproduction and mailing costs can be substantially reduced if the procurement is large enough by using microfilm supported by a computerized listing of documents. Organizations contracting for hardware systems are often required to transfer large quantities of such documentation to prospective bidders for study. Each document is reduced according to its relative size so that blowback to hard copy is logically proportional. The particular document can then be easily located by referring to the computer printout which is organized by specific technical purpose. A typical arrangement might include a section for project control documents, design requirements, engineering drawing or parts lists. The bidders receive rolls of film and the computer printout. They can either view the film or reproduce the portions they select. The complete system is described in an article entitled "A 35 mm Microfilm System for Efficient Transfer of Information" by Leo R. Lunine, Microfilm Journal, Summer 1980. Questions concerning the system may be referred to Michael Fisher, JPL, FTS 792-6162.

Contractor News

TRW, Redondo Beach, Calif., has been selected to negotiate a $26.3 million dollar contract to develop, integrate, and install the Space Telescope Science Operations Ground System for NASA's Goddard Space Flight Center, Greenbelt, Md. The cost-plus-award-fee contract calls for an initial 4-year agreement with a 1-year option for software maintenance. The Science Operations Ground System consists of three functional elements, two of which will perform post observation data processing and science planning at the Space Telescope Science Institute, Johns Hopkins University, Baltimore. The other element, to be located at Goddard, performs instantaneous spacecraft instrumentation checks and observations scheduling. The award calls for TRW to provide the Institute complex astronomical data storage capability over the project lifetime.

From On High—STS-2 view of the Earth showing clouds over the Pacific Ocean with a full moon, taken from an altitude of approximately 161 statute miles.

McDonnell Douglas Astronautics Co., Huntington Beach, Calif. has been awarded a letter contract by NASA's Goddard Space Flight Center, Greenbelt, Md., to configure, check out and launch Delta space vehicles. This letter contract is expected to lead to a fixed-price incentive contract covering a two-year period starting Oct. 1, 1981. Estimated value of the letter contract is $26 million. Delta launch vehicles are used to place a variety of communications and scientific satellites in orbit. An estimated 13 launches are to be accomplished during the contract period.

International Business Machines Corp., Cape Canaveral, Fla., has won a three year renewal of an existing contract at NASA's Kennedy Space Center. The cost-plus-award-fee contract is for a value of $27,996,434, bringing the total value of the contract to $84,355,534 to date. Under the contract, IBM performs systems engineering and software development services in support of the Space Shuttle Launch Processing System at Kennedy and at Vandenberg Air Force Base in California. The term of the contract extension runs from October 1, 1981 through September 30, 1984.

Vought Corp., aerospace subsidiary of **LTV Corp.**, Dallas, has been awarded a contract for systems management of the Scout launch vehicle by NASA's Langley Research Center, Hampton, Va. The contract, valued at just over $39 million, is a three-year continuation of a similar contract awarded in 1976 and modified in 1979. The new contract begins Nov. 1, 1981. Under terms of the contract, Vought will provide all systems management, which includes systems engineering, reliability and quality assurance programs, vehicle processing and launch and logistics support services.

Modern Machine & Tool Co., Newport News, Va., has been selected by NASA's Langley Research Center, Hampton, Va., for negotiation leading to award of contract for force and strain measuring instrument support services. Typically, force and strain measurements are an integral part of wind tunnel and other testing. The cost-plus-fixed-fee contract, valued at approximately $3.2 million, includes the personnel, equipment, materials and facilities necessary to perform engineering design studies and the fabrication, calibration, installation, maintenance and repair of force-measuring transducers and related accessories. The three-year contract will be managed by Langley. The contractor will supply all personnel, materials and facilities to design, manufacture and structurally test the blades. In addition, the contractor will conduct a test of the blades in the Ames 40 by 80-foot wind tunnel and optionally conduct, in conjunction with government personnel, 30 hours of flight testing.

Boeing-Vertol Co., a division of **The Boeing Co.**, Ridley Park, Pa., has been selected by NASA's Ames Research Center, Mountain View, Calif., for final negotiations of a contract for the development of advanced technology rotor blades. Boeing-Vertol's estimated value of the six-year contract is approximately $13 million. The new rotor blades, which will be flown on the NASA/Army Tilt Rotor Research Aircraft, will provide increased performance and margins of safety and will demonstrate the use of advanced composite materials in this type of aircraft.

Lockheed Engineering and Management Services Co. Inc., Houston, has been selected by NASA for negotiations leading to award of a contract to manage and provide complete data processing support services for the Information Processing Facility at the Goddard Space Flight Center, Greenbelt, Md. The cost-plus-award-fee contract will be for an initial two-year period beginning March 1, 1982, with options totalling an additional three years. The contractor's proposed estimated cost for the initial two-year contract is approximately $38 million. The contract will call for Lockheed to furnish complete data processing support services including overall management of the facility; the five functional centers; equipment; systems engineering; software; configuration management; maintenance; test and calibration of equipment; operation of the systems; documentation; facility administration; and compliance with center security, safety and health regulations.

Boeing Aerospace Co., Seattle, has been selected by NASA's Marshall Space Flight Center, Huntsville, Ala., for negotiation of a $250,000 1-year contract to study the concept of an unmanned launch vehicle, developed from recoverable Space Shuttle components. The unmanned vehicle, called the SRB-X, referring in part to the initials of the Space Shuttle's recoverable Solid Rocket Boosters, would augment the Space Shuttle missions. A recent "request for proposal," issued by the Marshall Center, had invited interested firms to describe how they would accomplish preliminary definition of unmanned launch vehicles that would use Solid Rocket Boosters and motors as principal components. The study will be divided into two six-month periods—the first in which Boeing will analyze various configurations that the unmanned vehicle might take, and the second in which Boeing will be required to define in greater detail those particular options that seem most promising. NASA has assigned management responsibility of the SRB-X study to Marshall.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
Columbia (OV-102)	March	KSC	OSS-1
Columbia (OV-102)	July	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B, Telesat-E, OSTA-2

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-D.	February 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Westar-IV	February 18	Delta	ESMC	Western Union communications. Reimbursable.
Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
Intelsat V-E	May	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Landsat-D	July	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
Westar-V	September	Delta	ESMC	Western Union communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

*Successful launch

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

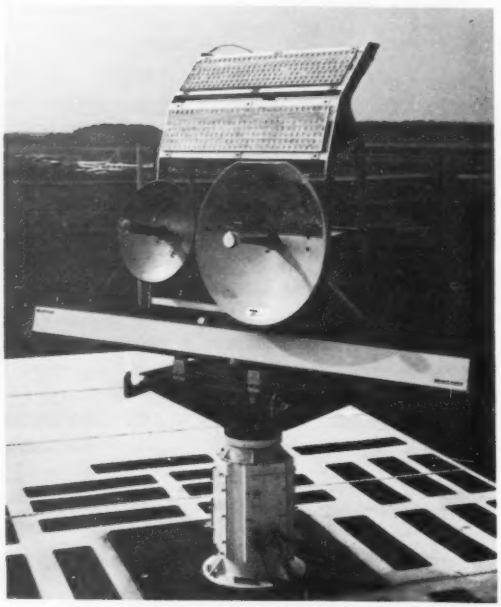
Inventor(s) & Employer	Title	Patent No.	Installation
Peter C. Wood, E. Vernon Ballou, and Prof. Leroy A. Spitze, San Jose State University Foundation, Calif.	Use of glow discharge in fluidized beds	4,303,961	ARC
James R. Currie, NASA/MSFC	Solar energy control system	4,304,219	MSFC
Reid A. Hull, NASA/LaRC	Moving body arresting line	4,304,320	LaRC
Anthony S. Girala, NASA/JSC	Open ended tubing cutters	4,305,205	JSC
William D. Kray, Talladega College, Talladega, Ala., and Robert W. Rosser, NASA/Ames	Synthesis of multifunction triaryltrifluoroethanes	4,307,024	ARC
Harold J. Walker, NASA/DFRC	Annular wing	4,307,856	DFRC
Ralph V. Sawyer and Bill Szuwalski, NASA/DFRC	Computer circuit card puller	4,307,510	DFRC
Howard E. Goldstein, Carlos Estrella, Marnell Smith and David A. Stewart, NASA/Ames and Daniel B. Leiser, Stanford University, Stanford, Calif.	Adjustable high emittance gap filler	4,308,309	ARC
Boris L. Seidel and Dan A. Bathker, Caltech/JPL	Antenna feed system for receiving circular polarization and transmitting polarization	4,308,541	NRO/JPL
Zenon Popinski, Caltech/JPL	Automotive absorption air conditioner utilizing solar and motor waste heat	4,307,575	NRO/JPL

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Automated Air Traffic Control

There are almost 200,000 general aviation aircraft operating into some 14,000 U.S. airports, mostly relatively small fields which do not have control towers. To enhance safety at high-traffic uncontrolled airports, NASA has developed in cooperation with the Federal Aviation Administration an experimental Automated Pilot Advisory System (APAS). The system provides pilots with airport, traffic and weather information in the vicinity of uncontrolled airports, and helps pilots to better meet the "see and be seen" requirement associated with visual flight rule operations. APAS has been successfully demonstrated at Manassas Municipal Airport, a busy general aviation field in northern Virginia.



The principal elements of APAS are radar (photo below left) for tracking approaching and departing aircraft, a computer system, weather sensors, and a transmitter for computer-generated voice reports to pilots. For the demonstrations, the APAS equipment was housed in a trailer containing an operator's control panel and instrumentation for checking the system's performance. An operational system concept would be untended and contained in a closet-sized package.

Radar and weather sensor information is fed into the computer system, which translates it into two types of voice advisories for pilots in the area. For advisory reception, user aircraft need no special equipment other than a standard VHF radio tuned to the proper frequency. Every 20 seconds, the computer-generated traffic advisory informs pilots how many aircraft are in the traffic pattern and where they are. Airport advisories broadcast every two minutes provide additional information: they identify the airport, indicate which runway is active, and relate wind speed, direction and other weather data.

In the Manassas demonstration, APAS achieved tracking accuracies approaching 100 percent; the system handled 250 to 300 aircraft a week and as many as 10 airplanes at one time.

*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

NASA
National Aeronautics and Space Administration

For the benefit of all . .

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